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NATIONAL GRID

The Narragansett Electric Company
E183W

Underground Project Investigation
& Estimate Assumptions

PROJECT NUMBER:
134776

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POWER ENGINEERS

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10.13.2014	T. Goyette	Original
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1 PROJECT DESCRIPTION

The Narragansett Electric Company d/b/a National Grid (National Grid) retained POWER Engineers, Inc. (POWER) for engineering and design services to support the route verification, cost estimating, permitting, licensing and installation of a proposed underground 115 kV electric transmission line in Providence and East Providence, RI. The proposed line will be installed between National Grid's existing Franklin Square Substation and a proposed overhead to underground transition substation on Mauran Avenue in East Providence, RI. The new underground line will replace an existing overhead transmission line installed in the same vicinity.

The proposed transmission line will be approximately 1.2 miles in length and will be rated for 398 MVA (2000 Amps). The cable system will require multiple construction methods including open cut trenching, jack & bores, and horizontal directional drilling (HDD). Approximately 2,300 of the 6,330 foot route will be installed in trenchless installations including two (2) HDDs and one (1) jack & bore.

This report outlines the tasks performed as part of the design and engineering efforts undertaken to develop construction grade estimates for the project.

1.1 Route

The route for the proposed transmission line begins at the Franklin Square Substation in Providence, Rhode Island. The existing E183W line will transition from overhead to underground in the parking lot outside of the guard house of the Franklin Square Substation. The installation would be performed by open cut trench excavation for an approximate 200 feet in a northeast direction in the parking lot of the Franklin Square Substation. From this point a horizontal directional drill will be utilized to cross the Providence River. This HDD would span for approximately 1,200 feet in an easterly direction under the Providence River and South Water Street. It would then exit into a parking lot at the corner of Tockwotten Street and South Water Street. At this point the underground system will transition back to an open cut trench excavation.

The underground line will proceed through the parking lot for a brief distance before turning north east up Tockwotton Street for 600 feet. At this point the alignment will parallel I-195 and will be going through the strip of grass in between I-195 and the off ramp for exit 2. The approximate distance for this is 200 feet, afterwards the line crosses under I-195. An extension of the Fox Point Hurricane barrier is built into the relocated I-195 highway. This prevents an open cut trenching method from being utilized in the underpasses of the bridge. For this reason a trenchless technology of either jack & bore or pipe jacking will be utilized to cross underneath I-195 from the grass strip and exit around India Street (approximately 275 feet).

After the I-195 crossing the underground line will head east down India Street and into India Point Park for approximately 2,400 feet. The open cut trench will terminate to the south of the Brown University Boathouse where it will transition into the routes last HDD to cross the Seekonk River. This is the shorter of the two HDDs at an approximate length of 950 feet. The HDD will exit next to the transition station on Mauran Avenue where it will be terminated at the new substation.

1.2 Survey & Mapping

POWER subcontracted the survey and mapping efforts to generate the base mapping for the project. The base maps were used to develop the plan and profile drawings required for construction. In developing the base mapping the following tasks were completed:

- Coordinated and performed an aerial flight over the project area;
  - Aerial photography used to set project controls and establish visual points of reference for the mapping
- Collected and reviewed available mapping and data from the following utilities to identify existing infrastructure (type, number and location)
  - National Grid – Electric & Gas
  - Verizon – Communication
  - Cox Communications – Communication
  - Narragansett Bay Commission
  - Municipal Water
- Field surveys conducted to verify location of utility and other surficial detail not gathered as part of the aerial data acquisition efforts.
- Coordination of collected data into a consolidated base map of the project area

1.3 Marine Survey & Investigation

To support the investigation and design of the two river crossings, POWER subcontracted with a marine surveying company to perform a multi-sensor geophysical survey of the Providence and Seekonk Rivers.

The survey program consisted of the acquisition of multi-sensor geophysical data (hydrographic, sub-bottom profiling, magnetometer and side scan sonar imagery) along the proposed transmission line alignment. Survey investigations were performed within an approximate 100-foot wide corridor centered on the proposed HDD alignment across each river. Track-line spacing within the survey corridors was established at 50-foot intervals. Along all survey tracks, the surveyor acquired hydrographic, sub-bottom profiling and magnetometer data. Side scan sonar imagery was acquired along specific tracks with the intent of providing close to 100 percent overlapping coverage of the bottom within the entire survey corridor. Sonar imagery data will be used for precisely locating specific objects and features exposed on the bottom (including abandon piles, debris, pipes, cables, rock outcrops) and mapping varying sediment types.

1.4 Geotechnical & Geothermal Investigation

In addition to the surveying and mapping efforts along the proposed transmission line corridor, POWER subcontracted with a geotechnical investigation contractor to obtain subsurface information along the land and marine route.

A total of twelve (12) drilled soil borings were taken in the project area to identify and classify underlying soil conditions along the proposed transmission line. The soil borings were advanced to a depth of approximately fifteen (15) feet at each location, except for the borings located at the landfall of each proposed horizontal directional drill. These borings (4 total) were advanced to a depth of sixty (60) feet to support the design of the directional drill alignments.

In addition to the twelve land based borings, two (2) borings were performed in the Providence River and two (2) borings were performed in the Seekonk River. These borings were advanced to a depth of eighty (80) feet beneath the mudline.

Soil samples from each boring location were collected and sent to a third party laboratory for thermal property analysis. Laboratory tests on selected samples were performed to cover the range of soils encountered. A thermal evaluation report was prepared including soil descriptions, measurements of moisture content, density, organic content and thermal dry-out tests (thermal resistivity vs. moisture content).

1.5 Transmission Line Design & Identification

POWER reviewed the information obtained through the field investigation efforts outlined in the previous tasks to select a preferred centerline for the proposed transmission line facilities. Manhole locations and configurations were identified and added to the base maps. In addition, the centerline of the proposed ductbank was selected and shown on the base map. In siting the manhole and centerline locations, POWER considered the routing, raceway elevations, burial depths, clearances to obstructions, crossings, horizontal and vertical curves, cable lengths, cable pulling tensions, site constraints, crossings, burial depths, construction access, grounding, installation and maintenance of the facilities.

Ampacity calculations were performed to determine the appropriate conductor size for the cable considering at a minimum: burial depth, cable spacing, transmission voltage mutual heating, distribution cable mutual heating, soil thermal conductivity, insulation wall thickness, earth ambient temperature, air ambient temperature, load factor, dielectric losses, conductor material and anticipated load requirements.

1.6 Cable System Description

POWER performed cable ampacity calculations for the proposed underground transmission line alignment. Ampacity calculations were performed using CYME International's Cable Ampacity Program (CAP) to model the cable system based on the agreed upon design criteria and the measurements obtained during the field investigation (thermal resistivities, ambient soil temperatures, etc.)

Based on these calculations, POWER has confirmed that National Grid's proposed cable system design consisting of two sets of 3000kcmil copper solid dielectric insulated cables will achieve the desired capacity of 2000 amperes.

1.7 Cost Estimate Assumptions

To support National Grid's permitting and licensing efforts, POWER developed project cost estimates. The cost estimates are based on pricing obtained from the following sources:

- Budgetary estimates for cable and accessories from several cable manufacturers

- Construction rates obtained from area contractors and recent projects in the New England area with similar scopes of work (voltage, length, pipe-jackings, etc.)
- Consultation with a contractor specializing in horizontal directional drill construction methodology

The following assumptions were used in the development of the cost estimate.

1. Materials used in the cost estimates meet all applicable industry standards.
2. Construction would be performed by qualified craftsmen experienced in installing high voltage XLPE underground and submarine transmission systems.
3. Due to the volatility of material costs, these estimates are subject to market fluctuations.
4. Costs to obtain all environmental, local, state, and federal permits and mitigation as required are not included.
5. Costs to obtain all necessary right-of-way, easement, and property as required are not included.
6. One spare cable reel, one spare termination and two spare splices have been included in the estimates.
7. Costs to install a fiber optic cable for communication are included.
8. Costs to include the installation of temperature monitoring equipment for the cable system are included.
9. Costs for reactive compensation are not included. A system study would need to be conducted to determine the detailed engineering and construction requirements for reactive compensation, if required.
10. Cost estimates assumed 10% open cut trench installation would be through rock (based on a combination of historical construction efforts in this area and the geotechnical investigation)
11. Cost estimates assumed dewatering of the trench would be required along 75% of the cable route due to the proximity of the tidal rivers.
12. Civil contingency of 25%
13. Electrical contingency of 15%
14. No sales tax included
15. No internal National Grid overheads included.

1.8 Summary

To assist National Grid's engineering department with permitting & licensing of the proposed 115kV underground transmission line, E183W, POWER performed a series of field investigations to develop plan & profile drawings and construction grade estimates.